

**REMARKS****Amendments to the Specification**

The paragraph at page 1, lines 8 through 14, has been amended to insert the recitation of Celazole®-brand polybenzimidazoles, as suggested by the Examiner.

The paragraph at page 2, lines 4 through 13, has been amended to insert the recitation of Rikukawa et al., as suggested by the Examiner.

**Amendments to Claims**

Claims 18, 19 and 25 have been amended to correct an improper invocation of a Markush group and to delete selected values of certain substituents.

Claim 19 has been further amended to correct typographical errors.

Claim 20 has been amended to correct a typographical error (omitted word “further”).

Claim 25 has been further amended to correct typographical errors and to add the missing definitions of variables as they appear in Claim 18. In particular, the permitted values of variables the R<sup>6</sup> and R<sup>7</sup> as they appear in Claim 25 now include hydrogen since the process recited in Claim 25 can be used to obtain functional polyazole of both Claims 18 and 19.

Claim 28 has been cancelled.

These amendment introduce no new matter.

**Objections to Specification**

The Examiner objected to the specification on the following grounds:

- the use of the phrase “Rikukawa *et al.*” on page 2, line 11 is unclear; and
- the trademark CELAZOLE® has not been spelled with capital letter.

Applicants amended the specification to introduce the phrase “Rikukawa *et al.*” with reference to a citation and to capitalize the trademark term. Applicants believe that these amendments address the Examiner’s objections.

### Objections to Claims

The Examiner objected to Claims 18, 19, 25 and 28 on the grounds of improper invocation of a Markush group. Additionally, the Examiner objected to Claims 25 and 28 due to the use of the plural form “formulae”.

Applicants amended Claims 18, 19 and 25 as suggested by the Examiner. Claim 28 has been cancelled. Applicants believe that these amendments address the Examiner’s objections.

The Examiner objected to Claim 20 as being improperly dependent on Claim 18. The Examiner stated that the polyazole of formula (5a), recited in Claim 20, does not fall within the scope of Claim 18.

Applicants amended Claim 20 to state that the claimed functionalized polyazole *further* comprises recurring benzimidazole units of the formula (5a). Applicants believe that the instant amendment renders Claim 20 properly dependent on Claim 18.

### Claim Rejection Under 35 U.S.C. §112

The Examiner rejected Claim 20 under 35 U.S.C. §112, second paragraph, as being indefinite. The Examiner’s ground for the instant rejection is the concurrently advanced objection to Claim 20 as being improperly dependent on Claim 18.

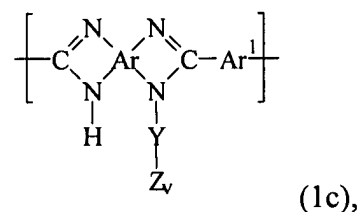
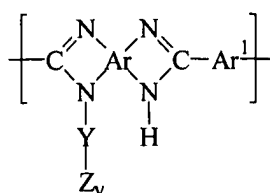
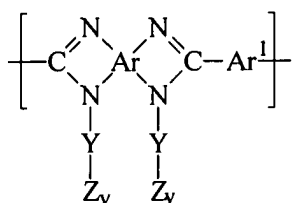
Applicants amended Claim 20 to state that the claimed functionalized polyazole *further* comprises recurring benzimidazole units of the formula (5a). Applicants believe that the instant amendment addresses the issues raised by the Examiner.

Reconsideration and withdrawal of the rejection are respectfully requested.

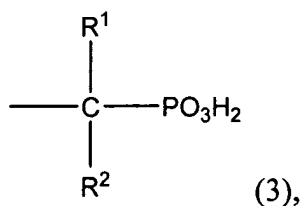
### Claim Rejection Under 35 U.S.C. §102(b) over Bessho *et al.*

The Examiner rejected Claims 18-20 and 23-28 as being anticipated by Bessho *et al.*, JP 09-110982 (“Bessho”).

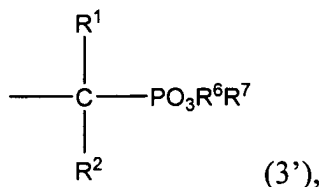
With respect to Claims 18-20 and 23-24, the Examiner stated Bessho discloses the compounds which meet formulas (1a), (1b) and (1c),



as recited in independent Claims 18, 19 and 25, wherein Ar is a tetravalent aromatic group, Ar<sup>1</sup> is a heteroaromatic group, Y is a bond or a group having from 2 to 5 carbon atoms, v is 10, and where Z (in Claim 18) and Z' (in Claim 19) are selected from either formula (3)



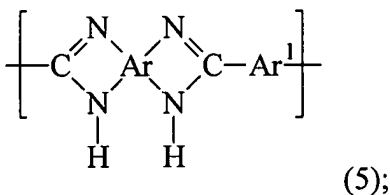
or formula (3')



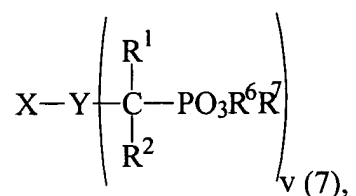
in which R<sup>1</sup> and R<sup>2</sup> are hydrogen atoms. The Examiner also stated that the solubility of such a polyazole, as recited in Claim 18, is expected to be comparable to that of the polyazoles of the instant application.

With respect to Claim 25, the Examiner stated that Bessho discloses the process of preparing the polyazole of Claim 19, comprising the steps of:

- dissolving a polymer having a recurring subunit that meets the definitions of formula (5)



- reacting the above solution with a CH<sub>3</sub>O<sup>-</sup>, a base, producing a second solution; and
- reacting the second solution with a compound that meets the definitions of formula (7)

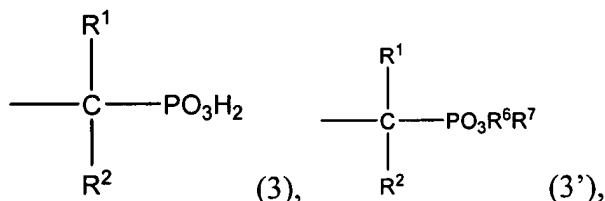


where R<sup>1</sup> and R<sup>2</sup> are hydrogen atoms, X is a leaving group, Y is a bond or a group having 2 to 5 carbon atoms, and v is 10.

By the present amendment, Applicants amended independent Claims 18, 19 and 25. Applicants submit that Claims 18, 19 and 25 as amended are both novel and non-obvious over Bessho.

#### *Novelty*

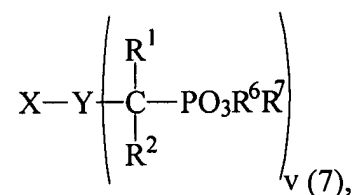
Regarding Claims 18 and 19, the Examiner stated that, the compounds disclosed by Bessho satisfy the definitions of formulas (1a), (1b), and (1c) only when the variables Z and Z' are selected from formula (3) (for Claim 18) or formula (3') (for Claim 19):



in which R<sup>1</sup> and R<sup>2</sup> are hydrogen atoms.

Applicants amended Claim 18 to delete the recitation that the variable Z can take a value shown by formula (3). Likewise, Claim 19 has been amended to delete the recitation that the variable Z' can take the value shown by formula (3'). As such, the compounds disclosed by Bessho no longer fall within the scope of Claims 18 and 19. Accordingly, base claims 18 and 19, as well as claims dependent thereon, are novel over Bessho.

Regarding Claim 25, the Examiner stated that the process of preparing the polyazole disclosed by Bessho meets the definitions of Claim 25 only when the phosphate used in step (C) is the phosphate of formula (7):



in which R1 and R2 are hydrogen atoms, X is a leaving group, Y is a bond or a group having 2 to 5 carbon atoms, and v is 10.

Applicants amended Claim 25 to delete the recitation that the phosphate used in step (C) is described by formula (7). As such, the methods disclosed by Bessho no longer fall within the scope of Claim 25. Accordingly, base Claim 25 as well as claims dependent thereon are novel over Bessho.

### *Obviousness*

Applicants further submit that Claims 18, 19 and 25 as amended are non-obvious in view of Bessho.

Applicants' invention is based on the discovery that certain functionalized polyazoles are highly soluble in organic solvent and possess proton conductivity at elevated temperature of at least 120°C. (See page 4, lines 7-21 of the instant specification.) Prior to Applicants' discovery, and based on the teachings of the prior art, a person skilled in the art would expect that polyazole materials would *not* be soluble in organic solvent. *E.g.*, Rikukawa et al, Prog. Polym. Sci. 25 (2000) 1463-1502, enclosed herein as reference C4, cited in the IDS, and discussed on page 4, lines 7-12 of the specification, states that polyazole polymers are insoluble in organic solvents due to aggregation of phosphate groups.

Surprisingly, and contrary to the teachings of the art accepted at the time the instant invention was made (such as Rikukawa *et al.*), Applicants discovered that when polyazole polymers are functionalized with phosphonic acid functionalities, the resulting materials possess unpredictable advantages. For example, instant materials are unexpectedly soluble in organic solvent (see page 16, lines 10-14 of the instant specification). Such solubility advantageously results in homogenous mixtures, as disclosed on page 4, lines 14-16 of the instant specification. Furthermore, the conductivity of the materials of the present invention is also advantageously high: the instant materials show a conductivity of at least 0.01 S/cm (see specification on page 4, lines 18-21) as measured at 120 °C without water (see specification on page 18, line 22 through page 19, line 9). Without being bound by any specific theory, it is believed that the functionalization of polyazole by the phosphate groups contributes to both high solubility and high conductivity in the absence of water.

Applicants note that base Claims 18, 19 and 25 as amended recite the materials and methods that employ twice the number of the  $-(\text{PO}_3\text{R}_2\text{R}_3)$  functionality compared to the polyazoles disclosed in Bessho. This means that at least double the amount of  $-(\text{PO}_3\text{R}_2\text{R}_3)$  groups are present per unit of a polyazole film or membrane. This is believed to not only cause higher proton conductivity, but also is believed to result in the functionalized polymer being more soluble in organic solvent.

Turning now the Bessho reference, there is no teachings, mentioning or suggestion of desirability of producing materials having high solubility in organic solvents or conductivity at elevated temperature without water anywhere in Besso. Nor does Besso or other references of record teach an approach that would allow to increase both solubility in organic solvents and conductivity at elevated temperatures in the absence of water. Furthermore, one of ordinary skill would not be motivated to modify the materials disclosed by Bessho in a manner that would result in the Applicants' claimed materials. Indeed, such modification, which would double the number of the phosphonic acid functionalities, was taught by the art accepted at the time of the instant invention was made to *cause* lower solubility. Finally, the advantages possessed by the Applicants' claimed materials are unpredictable in view of Bessho's teachings.

It follows that base Claims 18, 19 and 25 as amended, as well as claims dependent thereon, are non-obvious over Bessho.

Reconsideration and withdrawal of the rejection are respectfully requested.

#### Claim Rejection Under 35 U.S.C. §103(a)

The Examiner rejected dependent claims as being unpatentable under 35 U.S.C. §103(a) over a combination of Bessho and other references.

Specifically: Claims 21-22 stand rejected over a combination of Bessho and U.S. 5,525,436 (Savinelle) and Claims 29-36 stand rejected over a combination of Bessho and US2004/0062969 ("Sakaguchi").

Without acquiescing to the Examiner's arguments, Applicants submit that dependent Claims 21-22 and 29-36 are both novel and non-obvious over the cited references as claims dependent on Claims 18 and 25 as amended, which are both novel and non-obvious.

Reconsideration and withdrawal of the rejection are respectfully requested.

**Supplemental Information Disclosure Statement**

A Supplemental Information Disclosure Statement (SIDS) is being filed concurrently herewith. Entry of the SIDS is respectfully requested.

**CONCLUSION**

In view of the above amendments and remarks, it is believed that all claims are in condition for allowance, and it is respectfully requested that the application be passed to issue. If the Examiner feels that a telephone conference would expedite prosecution of this case, the Examiner is invited to call the undersigned.

Respectfully submitted,

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